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Systematics, bionomics and zoogeography of high Andean pedalioidines.
Part 13: Description and affinities of a new species from the uppermost
forests of the valley of Kosñipata, Cuzco
(Lepidoptera: Nymphalidae: Satyrinae)

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ABSTRACT. A new species *Pedaliodes acjanaco* is described, so far known only from the uppermost forests of the Kosñipata valley (Cuzco, Peru). It is related to *P. phoenix* LAMAS occurring in the Cordillera de Vilcabamba situated some 200 km northwest.

Key words: entomology, taxonomy, Andes, cloud forests, colour patterns, Cuzco, genitalia, new species, *Pedaliodes acjanaco* n. sp., *P. phoenix*, redescription, taxonomy

INTRODUCTION

Most pedalioidine Pronophilini occurring at high elevations in the central tropical Andes belong to widespread polytypic species or to lineages of closely related allopatric species. They are most frequently distributed throughout central and southern, in some cases northern, Peru and often Bolivia (PYRCZ et al. 2008). This is the case for several taxa described recently from Peru, such as the species groups of *Pedaliodes demathani*, *Pedaliodes sophismata* or *Pedaliodes cendreatea* (PYRCZ et al. 2008). The new species described in this paper is an exception because it is not only apparently a narrow endemic in the Andes of Cuzco, but is also highly distinctive and cannot be associated immediately with any widespread group of species. LAMAS (1999) described

Pedaliodes phoenix, an unusual species recognised by a dense tuft of hairy blueish-white scales covering the hindwing upperside basal one third, from the Cordillera de Vilcabamba. He pointed out that it is possibly most related to the new species described herein. A comparative analysis based on adult morphology is carried out in order to evaluate possible affinities of the two species.

MATERIALS AND METHODS

Field study took place during several expeditions carried out by the authors to the Andes of Cuzco in 1979-2009. Collecting was carried out with standard entomological nets. Van-Someren Rydon traps baited with dung were used in 2008. Type material was examined in MUSM, MZUJ, BMNH and ZMHB. Additional material was examined in other major collections, public and private. Male genitalia were dissected according to standard procedure, preserved in glycerol, and examined, alongside other morphological microstructures, under an Olympus SZX9 stereomicroscope. Adults were photographed with an Olympus E-500 digital camera, and colour plates were composed using Adobe PhotoShop version 7 software. The following abbreviations and collection codens were used:

FW: forewing;

HW: hindwing;

V: ventral surface;

D: dorsal surface;

BMNH: Natural History Museum, London, UK (formerly British Museum, Natural History);

MUSM: Museo de Historia Natural de la Universidad Nacional Mayor de San Marcos, Lima, Peru;

MZUJ: Muzeum Zoologiczne Uniwersytetu Jagiellońskiego, Kraków, Poland;

PBF: collection of Pierre Boyer, Le Puy Sainte Réparate, France;

TWP: collection of Tomasz Wilhelm Pyrcz, Warsaw, Poland (to be integrated into MZUJ);

ZMHB: Zoologische Museum Humboldt Universität, Berlin, Germany.

SYSTEMATIC OVERVIEW

***Pedaliodes acjanaco* LAMAS, VILORIA & PYRCZ n. sp.**

(Figs. 2, 3, 4, 6, 7)

TYPE LOCALITY

Paso Acjanaco, limite del Parque Nacional Manu, Cuzco, Peru

MATERIAL EXAMINED

PERU: HOLOTYPE (male): P. N. Manu, Acjanaco, CU, 3500 m, 01.VII.1991, M. Medina *leg.*; PARATYPES (128 males and 19 females): 4 males: same data as holotype;

2 males and 1 female: same data but 02.VII.1991; 3 females: same data but 03.VII.1991; 1 male: same data but 05.VII.1991; 3 males: same data but 09.VII.1991; 1 male: same data but 10.VII.1991; 1 male: same data but 11.VII.1991 (genit. prep. ALV-sn-95); 1 male: same data but 12.VII.1991; 1 female: same data but 30.VII.1991; 1 male and 2 females: Acjanaco-Tres Cruces, ca. 13° 18' S/71° 40' W, CU, 02.III. 1991, G. Ballon; 2 males and 1 female: Abra Acanaco, CU, 3500 m, 03.XII.1979, G. Lamas; 1 male: same data but 17.V.1984; 2 males: CU, Acjanaco, 3500 m, 1312/7137, 21.VIII. 2001, G. Lamas [MUSM]; 1 male: Callanga, Garlepp; 1 male: Pr. Cuzco, Callanga, 3000 m, 1898, Garlepp [ZMHB]; 1 male: Acjanaco – Pillcopata, Cuzco, Peru, 3300-3350 m, 20.V.2003, T. Pyrcz *leg.*; 13 males and 3 females: same data but 22.V.2003, T. Pyrcz *leg.* (female genit. prep. 01/01.10.2010); 1 male: same data but 25.V.2003, T. Pyrcz *leg.*; 11 males and 1 female: same data but 26.V.2003, T. Pyrcz *leg.*; 3 males: same data but 28.V.2003, T. Pyrcz *leg.*; 3 males: same data but 25.V.2003, T. Pyrcz *leg.*; 4 males: Tres Cruces, Cuzco, Peru, 3500-3550 m, 11.IX.2008, T. Pyrcz *leg.*; 4 males and 1 female: Cuzco, Vallee Cosnipata, “3”, A. Crosson-du-Cormier *leg.* [MZUJ]; 11 males: Cuzco, Abra Acjanaco vers Pilcopata km10 (Paucartambo) 3000-3100m, 24.II.2005, Pierre Boyer *leg.*; 52 males and 4 females: Cuzco, Acjanaco vers Boca Manu km2 à 6, 3300-3470 m, 22.V.2003, P. Boyer *leg.*; 3 males and 1 female: Cuzco, Tres Cruces, Paucartambo vers Pilcopata, 3500 m, 11.IX.2008, P. Boyer *leg.*; 1 female: Cuzco,

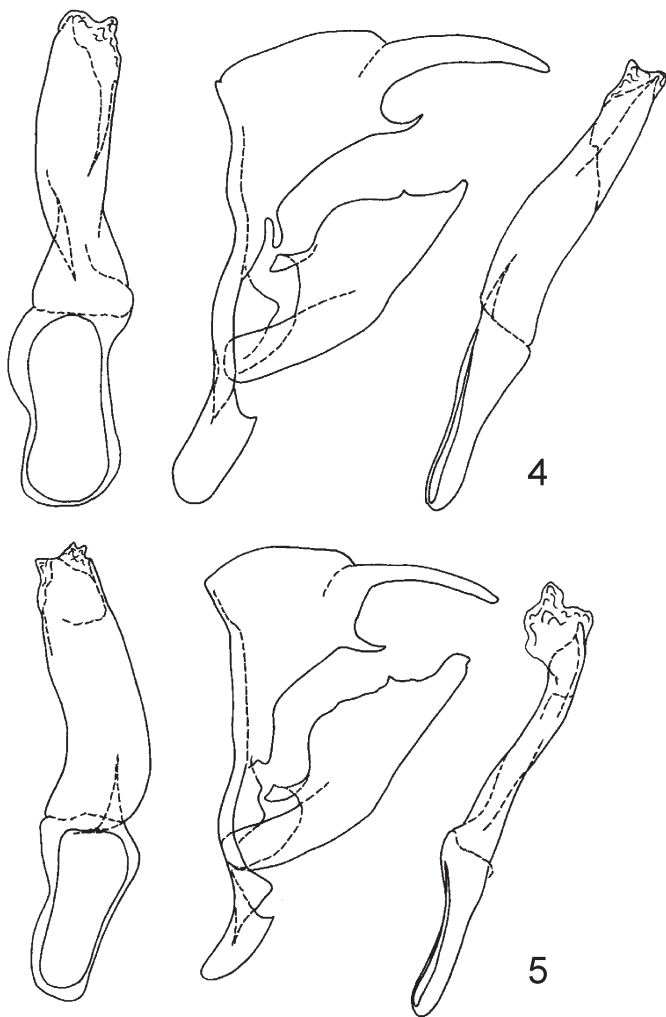


1-3. Adults (left: dorsum; right: venter): 1 – *Pedaliodes phoenix* male, paratype, 2 – *Pedaliodes acjanaco* male, paratype, 3 – *Pedaliodes acjanaco* female, paratype

Acjanaco vers Boca Manu, 3000 m, 15.IV.2005, O. Duviols *leg.*; 2 males: Cuzco, Paucartambo vers Pilcopata km 3, 3200 m, 9.IX.2008, P. Boyer *leg.*, [PBF].

DIAGNOSIS

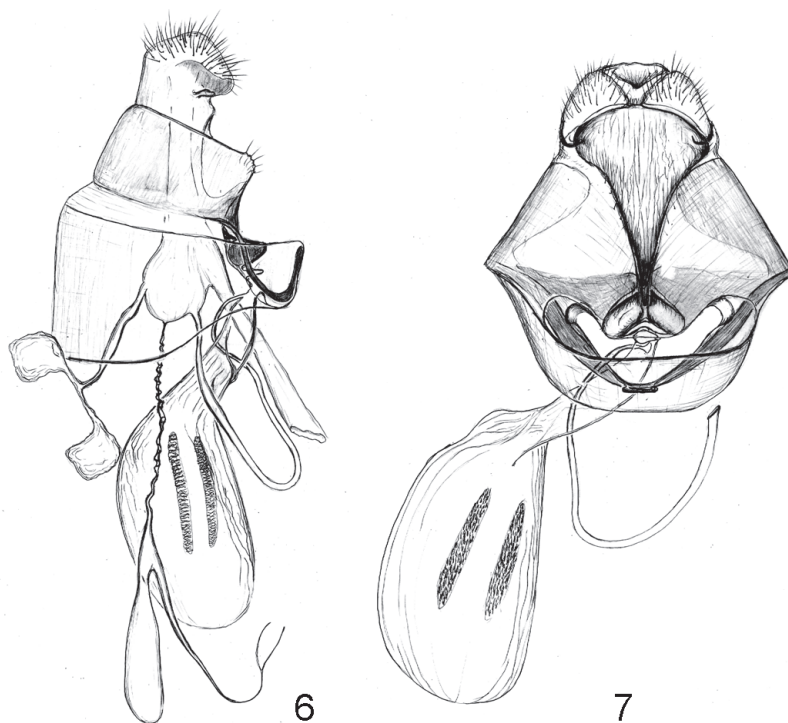
Upperside uniform brown, similar to several sympatric congeners. Best recognized by the brown underside, with a row of four, whitish submarginal dots on the forewing, and a series of dots, of which two in M3-Cu1 and Cu1-Cu2 the largest of all, and a slightly wavy whitish postdiscal band on the hindwing.



4, 5. Male genitalia (lateral view, aedeagus extracted in ventral and lateral view): 4 – *Pedaliodes acjanaco* paratype, 5 – *Pedaliodes phoenix* paratype

DESCRIPTION

MALE (Fig. 2): Head: eyes dark brown with black hairs; palpi twice as long as head, dark brown with brown and black scales and black hair; antennae to two fifths of the costa, shaft reddish brown, club dark coffee brown, formed gradually and comprising 15 to 16 subcylindrical segments. Thorax: dorsally coffee brown with many dark brown hairs, ventrally brown; legs light brown; Abdomen: light brown. Forewing: triangular with rounded tornus. FW length: 28-30.5, mean = 29.3 mm ($n = 129$). HW: rounded and softly crenulated. Androconial patch extends from FW wing base to median area, the area along 1A disconnected, marginally penetrates discal-cell. Upperside bright dark brown unicolour, slightly lightened on the anal margin, base and basal area of both wings, plus the anal region of the hindwing very hairy; light brown scales finely dusted over the costal and marginal regions of the forewing, a little less remarkable over the hindwing marginal area; a series of four very light brown submarginal dots (ca. 0.5 mm in diameter) on the forewing, placed in cells M1-M2, M2-M3, M3-Cu1 and Cu1-Cu2 respectively. Wings finely bordered with coffee brown scales alterned with white ones between the veins. HWD with two similar dots in in M3-Cu1 and Cu1-Cu2 respectively. FWV groundcolour brown less bright than that on the upperside, gradually lighter towards the tornus; darker brown speckling forming "ripple marks" all over the surface, but especially distinct on the costal, subapical and apical regions; apical region speckled



6, 7. *Pedaliodes acjanaco* paratype, female genitalia: 6 – lateral view, 7 – ventral view

also with reddish cinnamon brown; cream-white dusted over the subapical and apical regions until the outer margin, near the middle of the wing, particularly concentrated as a postdiscal lengthened spot on the costal area; a series of five white submarginal dots, from cell R5-M1 to Cu1-Cu2, the first one almost imperceptible, the other ones ca. 0.5 mm in diameter; outer border as on upperside. HWV groundcolour coffee brown, with a general brown irregular speckling, which tends to be reddish towards the costal and outer margins; cream-white finely dusted all over the wing, but almost imperceptible on the distal half; a lengthened, little distinct, discal spot of cream white on the costal region; the same colour forming a narrow, straight postdiscal band with fairly irregular edges, running from cell M2-M3 to Cu1-1A; a series of five submarginal dots from cell R5-M1 to Cu1-Cu2, the first three ca. 0.25 mm, and the last two ca. 0.8-1.0 mm in diameter; scales on the very edge of the wing as on upperside. **Genitalia** (Fig. 4): Uncus as long as tegumen and very gently curved; subunci short, one-fourth the length of uncus, slender and acute; saccus shallow and wide; valvae wide with a acute tip and a small, conical dorsal process; aedeagus strongly contorted and flattened, with a wide, rectangular proximal opening, two-fifths the length of aedeagus.

FEMALE (Fig. 3): FW length: 27-30 mm, mean = 27.9 (n = 19). Upperside differs from male in having a paler and less bright colour, as well as for the presence of a postdiscal lightening near the costa. Underside groundcolour drab with brown speckling irregularly distributed all over the surface but more thickly towards the base and the margins; apical regions of both wings almost completely lacking this speckling; central region of the forewing with a chestnut tone; some white scales lightening a subcostal sector of the forewing postdiscal area (between veins R5 and M2) and a narrow postdiscal stripe between veins M2 and Cu2 of the hindwing; some isolated white scales dispersed on the hindwing anal region; four submarginal white dots on the forewing (cells M1-M2 to Cu1-Cu2), and two more, bigger (1-1.5 mm in diameter) in cells M3-Cu1 and Cu1-Cu2 of the hindwing. External margins bordered with dark rufous with white scales between the veins. **Genitalia** (Figs. 6, 7): Papillae anales small. Antrum enclosed by a wide basin strengthen from the interior by a strongly sclerotized slit-like lamella antevaginalis (a common feature of all examined species of *Pedaliodes sensu lato*). Bursa copulatrix pear like, gradually narrowing toward posterior and transforming into ductus bursae. Signa approximately half the length of corpus bursae, roughly parallel, wide, with a spiny surface. Ductus bursae wide slightly sclerotized, similarly to other species of *Pedaliodes sensu stricte* but differing from *Neopedaliodes*, *Corderopedaliodes* and *Physcopedaliodes* all characterised by a strongly sclerotized ductus bursae, two-thirds the length of corpus bursae, slightly twisted. Ductus seminalis connects to ductus bursae near its proximal opening (differing in this respect from other examined species of *Pedaliodes stricte*, and also *Corderopedaliodes*, *Physcopedaliodes* and *Neopedaliodes*, in which ductus seminalis connects to ductus bursae near its opening into corpus bursae).

VARIATION

Several male paratypes show less underside cream-white scales, in such cases some submarginal dots are absent or reduced, and spots are in general more diffuse. Variation

among females has to do with the presence of a very thick marble-like speckling of brown to reddish on the underside of some specimens.

ETYMOLOGY

The name of this butterfly is derived from the type locality Acjanaco, an elevate place on the Amazon basin, on the borderline of Manu National Park in the department of Cuzco.

BIONOMICS

Pedaliodes acjanaco is known so far exclusively from the type locality. It occurs in the uppermost forest, keeping close to the ground in the humid gullies, rarely venturing onto open grassland above timberline. Its microsympatric congeners in this habitat are *P. ackeryi* PYRCZ & VILORIA and *P. phantasia* LAMAS, VILORIA & PYRCZ (PYRCZ et al. 2008). *P. acjanaco* was observed to feed from carnivorous animals dung in the lower paramo in the company of *Steremnia agraulis* Thieme, *Punapedaliodes flavopunctata* and an undescribed species of *Pedaliodes* (which unfortunately was not collected). It is seasonally very abundant in its habitat.

***Pedaliodes phoenix* LAMAS, 1999**

(Figs. 1, 5)

Pedaliodes phoenix LAMAS, 1999: 29, figs. 1 (male), 2 (female), 3 (male genitalia)

TYPE LOCALITY

Cordillera de Vilcabamba, Cuzco, Peru.

MATERIAL EXAMINED

PERU: HOLOTYPE (male): Cuzco, Cordillera de Vilcabamba, 11°40'S, 73°40'W, 12.VI.1997, G. Lamas *leg.*, MUSM; PARATYPES (57 males and 3 females): same data but 07-20.VI.1997, 55 males and 2 females [MUSM], 2 males [MZUJ].

REDESCRIPTION

MALE (Fig. 1): Head: eyes dark brown, hairy; palpi 2.5 times as long as head, dark brown with some yellowish scales laterally, densely hairy below; antennae reaching half costa, dark brown, checkered with orange brown. Thorax: densely covered with yellowish, reddish and dark brown hair, legs densely hairy and spiny, tibiae and tarsi with many yellowish scales. Abdomen: dorsally dark brown, ventrally dirty yellowish brown. Wings: FW length: 25-29 mm (n=58). FW triangular, apex acute, tornus slightly obtuse, outer margin slightly convex, very slightly undulated, fringes white and brown checkered. FWD dark brown, with conspicuous yellowish submarginal spots in M2-M3, M3-Cu1 and Cu1-Cu2, middle one largest, in a almost straight row. FWV costal, apical and outer areas conspicuously marbled with whitish, yellowish and reddish scales, submarginal whitish spots as above, slightly smaller; compact androconia in central area, invading discal-cell between bases of M3 and Cu2. HW: rounded, somewhat

scalloped, fringes brown. HWD dark brown; a conspicuous basal to postbasal light blue hairy scales patch; submarginal yellowish spots in M3-Cu1 and Cu1-Cu2, costal margin slightly paler. HWV extensively marbled with whitish, yellowish and reddish scales, yellowish inner margin behind 2A peppered with reddish-brown scales, two more or less continuous, convex, pale yellowish or whitish lines across disc, one discal, the outer postdiscal, submarginal whitish spots as above, but larger. **Genitalia** (Fig. 5): Uncus as long as tegumen, nearly straight; subunci short, one-fourth the length of uncus and slender; saccus shallow and wide; valvae wide with a blunt tip and a small, conical dorsal process; aedeagus strongly contorted and extremely flattened, with a wide proximal opening, gradually narrowing, two-fifths the length of aedeagus.

FEMALE (not illustrated): FW length: 27-28 mm (n=3). Very similar to male, but submarginal yellow spots on FW and HW larger and light discal markings on HW below thicker. Genitalia: not examined.

REMARKS

LAMAS (1999) speculated about the function of the conspicuous HWD furry bluish-white patch in *Pedaliodes phoenix* discarding its role in mate recognition based on the fact that the patch is present in both sexes. This assumption is basically correct, however the patch still can play a role in mating strategies, as specific locating signal.

Whitish-blue HWD patches are found in several species of the tribe Pronophilini. Interesting, almost all of them occur in the forest-paramo ecotone. In the department of Cuzco they are found in *Lasiophila piscina* THIEME and *Lymanopoda inaudita* PYRCZ (PYRCZ et al. in press). This strongly suggests that the light structure of this kind of heterogenous habitat favours the development of conspicuous sexual traits. Their possible mate locating functions and optical characteristics are being studied for *Cheimas opalinus* STAUDINGER (PYRCZ et al. in prep.).

Although HWD hairy scaling is a frequent feature of the Pronophilini, and particularly of high elevation *Pedaliodes*, only exceptionally they are coloured in a different way than the mostly brown wing ground colour. The only known example, apart from *Pedaliodes phoenix* is *Pedaliodes tatama* PYRCZ & RODRÍGUEZ, occurring in the forest-paramo ecotone and lower paramo in the northern part of the Colombian Western Cordillera, at elevations above 3600 m (PYRCZ & RODRÍGUEZ 2007). *P. tatama* belongs to a group of closely related allopatric species including *P. fassli* THIEME, *P. negreti* PYRCZ and *P. pheretias* (HEWITSON), of which only *P. tatama* possesses a conspicuous hairy patch. In *P. tatama* the patch is greenish-gray. Again, the bionomics are similar as for *P. phoenix*, suggesting a habitat selection favouring the development of this trait. In particular, the two localities are characterized by extremely perhumid conditions, even when compared to other high elevation Andean elfin forests and paramo.

LAMAS (1999) was correct in suggesting that that the species described herein as *Pedaliodes acjanaco* is the closest relative of *P. phoenix*. It was confirmed by morphological analysis. The two species have a very similar HWV colour pattern characterized by the nearly straight postdiscal band, which in *P. phoenix* is doubled by a parallel median band. ADAMS (1986) and PYRCZ et al. (2008) pointed out on several occasions that the patterns of HWV offer particularly good synapomorphic characters in evaluating

the relationships of *Pedaliodes* species. HWV colour patterns are far more informative than the comparison of dorsal colour patterns, which are often widely divergent even in closely related taxa, which is due to the strong habitat and sexual selection. This is the case for *P. phoenix* and *P. acjanaco*. Furthermore, the two species have a very similar wings shape, which is also an evolutionarily more stable character than dorsal colour patterns. Also, their male FWD androconial patch is nearly identical in shape. Male genitalia show common features, although they are also found in several Peruvian pedaliodines, so that their synapomorphous value has to be considered with reservation. The two species have similar valvae with a diagnostic small, conical dorsal process, short subunci, and flattened aedeagi.

Surprisingly, no species related to *P. phoenix* / *P. acjanaco* was discovered in the valley of Lucumayo, which is situated roughly mid-way between Kosñipata and Vilcabamba, even though that area was heavily sampled for butterflies at the elevations where a vicariant species would be expected to occur (PYRCZ et al. 2009). Although we cannot entirely rule out currently that such a species will be discovered in the future, its presence in the Lucumayo valley is highly unlikely.

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